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Dimethyltryptamine (DMT): Prevalence, user characteristics and abuse liability in a large global sample

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Abstract

This paper presents original research on prevalence, user characteristics and effect profile of N,N-dimethyltryptamine (DMT), a potent hallucinogenic which acts primarily through the serotonergic system. Data were obtained from the Global Drug Survey (an anonymous online survey of people, many of whom have used drugs) conducted between November and December 2012 with 22,289 responses. Lifetime prevalence of DMT use was 8.9% (n=1980) and past year prevalence use was 5.0% (n=1123). We explored the effect profile of DMT in 472 participants who identified DMT as the last new drug they had tried for the first time and compared it with ratings provided by other respondents on psilocybin (magic mushrooms), LSD and ketamine. DMT was most often smoked and offered a strong, intense, short-lived psychedelic high with relatively few negative effects or "come down". It had a larger proportion of new users compared with the other substances (24%), suggesting its popularity may increase. Overall, DMT seems to have a very desirable effect profile indicating a high abuse liability that maybe offset by a low urge to use more.

Keywords

Novel psychoactive substance, legal highs, DMT, Dimethyltryptamine, Indolealkylamine, ketamine, LSD, magic mushrooms

Introduction

N,N-dimethyltryptamine (DMT) is a naturally occurring tryptamine endogenous to both the mammalian brain (Christian et al., 1977) and flora worldwide (Halpern, 2004; Shulgin and Shulgin, 1997). Manske (1931) is credited as the first to synthesize DMT but it was Szara, inspired by the discovery of DMT in a snuff used in South American religious ceremonies (Szara, 2007), who first demonstrated that DMT, when administered intramuscularly, induces visual hallucinations and illusions, distortions of spatial perception and body image, disturbances of thoughts and euphoria in humans (Szara, 1956). The first wave of clinical research followed in the 1950s and 1960s, gaining momentum with the discovery that DMT can be found in the blood and urine of normal human subjects (Franzen and Gross, 1965). Following the passage of the Controlled Substances Act 1970, research into hallucinogens waned in both the United States and Europe for many years. Strassman pioneered contemporary research into hallucinogens and DMT in the 1990s based on his belief that the profound effects on consciousness they produced warranted further exploration (Strassman, 1995). He published a number of landmark studies including detailed dose-response experiments using the Hallucinogen Rating Scale to measure subjective experiences (Strassman and Qualls, 1994). This new interest continued with the publication of *Thikal*, Shulgin's personal study into the psychopharmacological properties of the tryptamines including DMT (Shulgin and Shulgin, 1997), which describes the subjective effects of smoked and oral preparations. Recent research has suggested that its serotonergic (5HT2a) and NMDA receptor properties could inform a pharmacological model of schizophrenia (Gouzoulis-Mayfrank et al., 2005, Heekeren et al., 2008), contributing to the theory that the 5HT2a and metabotropic glutamate systems might be involved in the disturbed cortical processes found in schizophrenia (González-Maeso et al., 2008).

DMT is an indolealkylamine hallucinogen derived from the amino acid tryptophan (Hill and Thomas, 2011) that is non-selective for 5-HT receptors, with moderate to high affinity for 5-HT1 and 5-HT2 subtypes (McKenna et al, 1990) and activity as both a 5-HT substrate and uptake inhibitor. However, its agonist action at 5-HT2a, common to other indoalkylamines and phenylaklyalmines, is thought to be primarily responsible for its key psychedelic effects (Cozzi et al., 2009; Halberstadt and Geyer, 2011; Nagai et al., 2007). DMT has putative activity at sigma-1 receptors which are ubiquitous across the central nervous system (Guitart et al., 2004), though the significance of this action in mediating the hallucinogenic effects of DMT is unknown (Fontanilla et al., 2009; Halberstadt and Geyer, 2011). Oral DMT undergoes considerable first-pass metabolism effects from the *monoamine oxidase* (MAO) enzyme system, necessitating the

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Table 1. Prevalence of common psychedelic substances used in total population (*n*=22,289).

	Ever used? (*n*, %)	Past year? (*n*, %)	Past month? (*n*, %)	Last new drug tried (*n*, %)	Lifetime vs. last new drug (%)	Mean number of days drug used in last month
Magic mushrooms	9604 (43.1%)	3586 (16.1%)	1180 (5.3%)	1157 (5.2%)	12.0%	1.8 (SD 2.7)
Ketamine	5784 (26.0%)	2505 (11.2%)	1182 (5.3%)	993 (4.5%)	17.2%	3.2 (SD 4.1)
LSD	8774 (39.4%)	3340 (15.0%)	1149 (5.2%)	1130 (5.1%)	12.9%	2.0 (SD 2.4)
DMT	1980 (8.9%)	1123 (5.0%)	363 (1.6%)	472 (2.1%)	23.8%	2.2 (SD 3.4)

Note: Lifetime vs. last new drug = the proportion of all lifetime users who report the drug as the last new drug they have tried

co-ingestion of a MAO inhibitor-containing plant, for example *Banisteriopsis caapi*, as is the practice in Ayahuasca brews (Cakic et al., 2010). More recently, ethnographic studies have reported administration via smoking as a plant mixture extract which avoids the first-pass metabolism. When smoked, a route not possible for other psychedelics, onset tends to be rapid (within a minute), with peak effect at 2–5 min and a short duration of action (20–60 min) (Haroz and Greenberg, 2005; Shulgin and Shulgin, 1997).

DMT has been found to produce profound changes to cognition described as "deep introspection" (Riba et al., 2006) and perception, particularly in the visual, auditory and somatosensory systems, such as visual hallucinations, brief simple auditory hallucinations and bodily dissociation (Strassman and Qualls, 1994). Like other hallucinogens, it exhibits mild stimulant effects with physiological changes such as raised heart rate, blood pressure and pupil diameter (Gillin et al., 1976; Strassman and Qualls, 1994; Szara, 1956).

In the UK and USA DMT is categorized as a Class A controlled substance and Schedule 1 drug respectively. Although previous studies have explored the subjective experiences and demographic characteristics of DMT users (Cakic et al., 2010; Strassman and Qualls, 1994) no research to date has sought to determine its prevalence and comparative effect profile relative to other commonly used psychedelics within a large contemporary global population of drug users. With the recent appearance of myriad novel psychoactive substances (many with hallucinogenic properties) the current study sought to assess the prevalence and appeal of a naturally occurring drug with a long history of use, namely DMT. To better understand its abuse profile, especially in light of the recent adoption of the smoking route, we sought to compare its effect and risk profile with other commonly used psychedelic drugs LSD, magic mushrooms (psilocybin) and ketamine.

Methods

The Global Drug Survey conducts annual anonymous online surveys of drug and alcohol use in partnership with global media partners (in 2012 these were The Guardian and Mixmag in the UK and Fairfax Media in Australia) with onward promotion through media partner websites and social networking sites such as Facebook, Reddit and Twitter. The research tool and methods are based on previous work by the group conducted over the last decade. Accessing a large sentinel drug-using population in this way allows for the rapid assessment and identification of novel drugs of abuse. Our team has successfully used this methodology to identify new drugs trends before they reach the wider community (McCambridge et al., 2006; Winstock et al., 2001, 2011b). Extensive discussion of the methods used, including their utility, validity and limitations have been discussed previously (Winstock and Barratt, 2013; Winstock et al., 2001; 2011a; 2012).

Results

Between November and December 2012 a total of 22,289 responses were received worldwide. This included 7360 (33.0%) respondents from the UK, 7784 (34.9%) from Australia, 3756 (16.9%) from the USA and 2164 (9.7%) from the Euro zone (using local currency as a proxy for country). Table 1 shows the reported DMT prevalence use in comparison with ketamine, LSD and magic mushrooms. As part of the methods we use to track emerging drug trends and profile their effects we sought further information on a subset of users who reported DMT as the last new drug they had tried for the first time. Of the total sample 2.1% (*n*=472) reported that DMT was the last new drug they had tried.

Demographic characteristics

Table 2 compares non-DMT users with those who reported lifetime DMT use and those for whom DMT was the last new drug tried.

Summary of results of those for whom DMT was the "last new drug tried"

The effect profile of DMT and other psychedelic drugs was determined by asking a number of "foot-printing" questions of users. These profiling questions were adapted from those in earlier risk profiling work carried out on mephedrone (Winstock and Marsden; 2010, Winstock et al., 2011b). Participants were asked to rank each drug against seven broad drug-effect variables on a scale from 0–10 where 10 is the maximum effect. The specific variables were pleasurable effect when high; strength of effect; negative effect when high; comedown; risk of harm when high (e.g. overdosing, or passing out); value for money; and urge to use more. Users were also asked to identify the route of use, time to onset and duration of peak effect, and nominate what the drug's predominate intoxicating effect was (e.g. stimulant, empathogenic, psychedelic, cannabis like, opioid like, other).

In order to better interpret the foot-printing effect profiling ratings we obtained regarding DMT, we also report matching foot-printing data from participants who nominated magic mushrooms, LSD or ketamine as being the last drug they had tried for

Table 2. Demographic data from DMT users and DMT non-users.

		DMT use – lifetime (*n*=1980)	DMT – last new drug (*n*=472)	DMT – never used (*n*=21,817)	Total (*n*=22,289)
Gender	**Male**	1222 (61.7)	374 (79.2)	13,676 (62.7)	14,050 (63.0)
	Female	589 (29.7)	75 (15.9)	6344 (29.1)	6419 (28.8)
	Missing	169 (8.5)	23 (4.9)	1797 (8.2)	1820 (8.2)
Age	**Mean (SD)**	32.1 (12.8)	28.5 (10.1)	31.5 (12.5)	31.4 (12.4)
Ethnicity	**White**	1731 (87.4)	411 (87.1)	19099 (87.5)	19,510 (87.5)
	Black	8 (0.5)	3 (0.6)	84 (0.4)	87 (0.3)
	Asian	44 (2.3)	8 (1.6)	454 (2.1)	462 (2.1)
	Mixed	62 (3.1)	23 (4.9)	689 (3.2)	712 (3.2)
	Other	48 (2.5)	19 (4.0)	587 (2.8)	606 (2.8)
	Missing	87 (4.4)	8 (1.7)	904 (4.1)	912 (4.1)
Sexual orientation	**Heterosexual**	1528 (77.2)	386 (81.8)	16,983 (77.8)	17,369 (77.9)
	Homosexual	154 (7.8)	22 (4.7)	1595 (7.3)	1617 (7.3)
	Bisexual	178 (9.0)	53 (11.2)	1925 (8.8)	1978 (8.9)
	Prefer not to say	31 (1.6)	9 (1.9)	429 (2.0)	438 (2.0)
	Missing	89 (4.5)	2 (0.4)	885 (4.1)	887 (4.0)
Wellbeing score	**Mean (SD)**	56.2 (18.5)	59.7 (13.1)	56.5 (17.9)	56.6 (17.9)
Personality disturbance	**SAPAS (1–8)**	2.9 (1.4)	2.7 (1.4)	2.8 (1.4)	2.8 (1.4)
Working	**Yes**	1344 (67.9)	347 (73.5)	14,879 (68.2)	15,226 (68.3)
	No	513 (25.9)	108 (22.9)	5650 (25.9)	5758 (25.8)
	Missing	123 (6.2)	17 (3.6)	1288 (5.9)	1305 (5.9)
Studying	**Yes**	709 (35.8)	211 (44.7)	8515 (39.0)	8726 (39.1)
	No	1169 (59.0)	253 (53.6)	12,280 (56.3)	12,533 (56.2)
	Missing	102 (5.2)	8 (1.7)	1022 (4.7)	1030 (4.6)
Unemployed	**Yes**	482 (24.3)	122 (25.8)	4929 (22.6)	5051 (22.7)
	No	1375 (69.4)	340 (72.0)	15,636 (71.7)	15,976 (71.7)
	Missing	123 (6.2)	10 (2.1)	1252 (5.7)	1262 (5.7)

SAPAS: Standardized assessment of personality

Table 3. Route of administration for DMT, ketamine, LSD and magic mushrooms.

Method	DMT (*n*, %)	Ketamine (*n*, %)	LSD (*n*, %)	Magic mushrooms (*n*, %)
Snort	10 (2.1)	884 (89.0)	2 (0.2)	2 (0.2)
Swallow	14 (3.0)	90 (9.1)	990 (87.8)	1030 (89.6)
Smoke	435 (92.2)	4 (0.4)	0 (0.0)	7 (0.6)
Inject	0 (0.0)	10 (1.0)	0 (0.0)	1 (0.1)
Other	13 (2.8)	5 (0.5)	136 (12.1)	110 (9.6)

the first time. The following results are therefore from a subpopulation of the 22,289 sample who listed DMT, 2.1% (*n*=472), ketamine, 4.5% (*n*=993), LSD 5.1% (*n*=1130) or magic mushrooms, 5.2% (*n*=1157) as the last new drug they had tried when completing the survey. The prevalence of lifetime psychedelic use within the DMT as last new drug tried group was considerable, with almost half (45.6%) reporting lifetime ketamine use and more than one-third reporting lifetime magic mushroom (36.9%) and LSD (33.5%) use.

The differences between routes of administration across the four substances examined are shown in Table 3. Only DMT was smoked, and ketamine was the only substance injected. For all the substances the most common source was a friend, with a drug dealer second. Figure 1 shows the reported time to peak onset for DMT, ketamine, magic mushrooms and LSD. The reported duration of effect for each substance is displayed in Table 4 and these are represented graphically in Figure 2, along with data from the other foot-printing items. Of the four substances examined, DMT had the shortest mean duration of effect at 23.8 (SD 33.9) minutes. Like the other substances, DMT was characterized by the vast majority of users as having a psychedelic effect (see Table 4). DMT, magic mushrooms and LSD had very similar proportions of users reporting strong urges to use more (see Table 4).

Discussion

This study represents the largest global study of DMT users ever conducted. The results confirm that DMT is considered by contemporary users to be a highly potent psychedelic drug with a

Table 4. Responses to foot-printing items for DMT, ketamine, LSD and magic mushrooms.

Drug feature	DMT (Smoked *n*=435) Mean (SD)	Ketamine (Nasal *n*=884)	LSD (Oral *n*=1130)	Magic mushroom (Oral *n*=1030)
Time to peak effect (min)	6.3 (8.0)	20.8 (28.0)	114.1 (75.7)	74.3 (48.6)
Duration of effect (min)	23.8 (33.9)	112 (126.6)	550.2 (265.4)	327.5 (174.
Strength of pleasure	7.3 (2.7)	5.4 (2.6)	7.3 (2.3)	6.8 (2.6)
Strength of effect	8.6 (2.3)	7.2 (2.2)	7.6 (2.1)	7.1 (2.3)
Negative effects whilst high	1.9 (2.4)	3.6 (2.8)	2.9 (2.7)	2.9 (2.8)
Urge to use more	1.3 (2.3)	3.0 (3.0)	1.5 (2.3)	1.4 (2.2)
Risk of harm	1.1 (1.8)	3.2 (2.9)	2.1 (2.6)	1.7 (2.3)
Comedown after use	1.2 (1.9)	2.4 (2.4)	3.3 (2.8)	2.1 (2.4)
Value for money	7.5 (2.8)	5.7 (2.9)	7.7 (2.6)	7.3 (2.7)

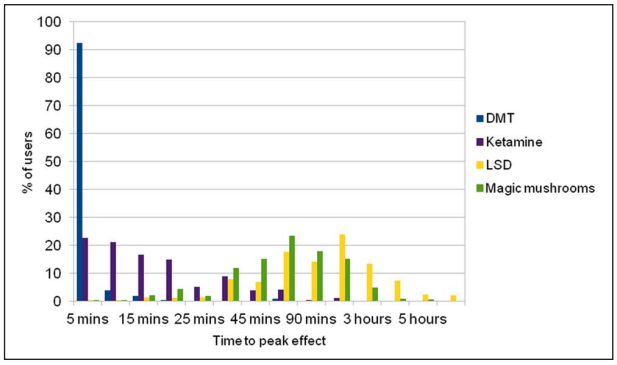

Figure 1. Percentage of users vs. reported time to peak effect for each substance.

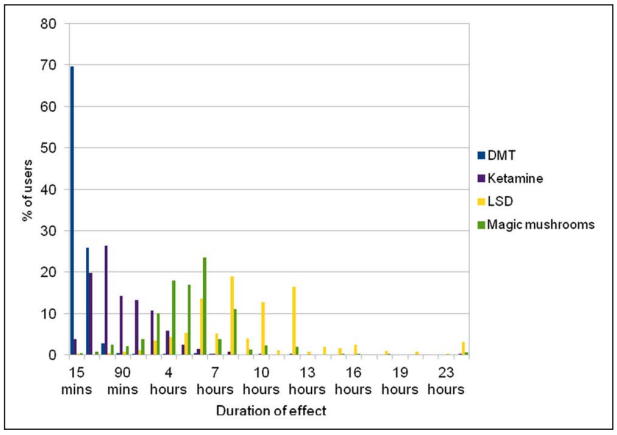

Figure 2. Percentage of users vs. reported duration of effect for each substance.

desirable effect profile. The ratio of users for whom DMT was the last new drug versus those who reported lifetime DMT use was higher than ketamine, LSD and magic mushrooms, suggesting that it may be an increasingly popular substance for those seeking an alternative to traditionally available hallucinogens. Despite its rapid onset of action (attributable to the smoking route), DMT was rated as having the lowest level of negative effects when high, perhaps due to its short duration of action. When compared with the recently popular pharmaceutical psychedelic ketamine, DMT appears to be more desirable across all effect parameters.

From a drug user's perspective, our data demonstrate that DMT possesses favourable characteristics in terms of strength of effect, pleasurability, and lack of negative effects, suggesting that DMT could have a high abuse liability. This positive effect profile may in part be due to its short duration of action permitting effective dose titration. Fortunately this short duration of action – which can be associated with a higher risk for dependence – did not appear to translate into a higher urge to use more DMT when using. In our sample, higher urge to use scores were seen for ketamine administered through the intranasal route, where dependence has been reported (Winstock et al., 2012). As with other psychedelics, a relatively mild comedown was reported following the use of DMT, negating the motivation incentive for use to relieve withdrawal. Our findings are consistent with previous research which suggests that hallucinogenic substances rarely lead to a strong urge to use more (Morgenstern et al., 1994) and have low abuse potential (Fábregas et al., 2010; Gable, 2007).

It terms of strength of effect, the majority of users rated the effect of DMT as stronger than ketamine, magic mushrooms and LSD. This is an important finding, almost certainly related to its smoking route of administration. Such potency of effect should prompt novice users to take significant care and advice when first using this drug since the rapid onset of an intense psychedelic effect may be unpleasant. That 14% of users found the effects of DMT to be different to any of the other drug classes may be explained by the limited drug use experience of a minority of respondents. The greater variation in 5-HT receptor interactions found with indolamines and indolakylamines such as DMT, which show less 5HT2a selectivity, may also be responsible for the differences in psychedelic experiences reported (Halberstadt and Geyer, 2011).

In terms of the administration of DMT, our findings support previous work (Cakic et al., 2010) that the most common method is smoking a mixture of DMT-containing constituents (92% of users). This may be due to a preference for avoiding the potential negative effects of ingesting an Ayahuasca brew, which typically leads to nausea and emesis, or simply because smoked DMT provides a more reliable and easily titratable experience. Furthermore, the inhalation route leads to the rapid onset of a strong, pleasurable psychedelic experience, demonstrated by 93% of users reporting a peak effect within 5 min, which was rated equally as

pleasurable as LSD and more pleasurable than both magic mushrooms and ketamine.

The overall findings suggest DMT has a reasonable safety profile, with few users reporting significant negative effects when high or following an episode of use. Given its serotonergic activity and the potential for co-administration of an MAO inhibitor, the main risks are likely to be to be of severe serotonin syndrome. However, this risk may be negated through administration via smoking. Little is known about the lethality of DMT in humans but, extrapolating from animal data, the human LD50 is estimated to be 560 mg, which gives a safety margin of 20 when the average oral dose of DMT in Ayahuasca of 27 mg is used (Gable, 2007). When a group of experienced DMT users were asked to rate the safety of DMT, 55% reported it to be "very safe" and 38% "quite safe" (Cakic et al., 2010). The same group was asked what they felt the main risks of DMT were, to which a "bad trip" was the most common response (51%), followed by the potential for psychospiritual problems (39%) and physiological problems (26%) including respiratory irritation and burns.

In this study, the new user subpopulation was more likely to be younger, male and currently in education when compared with those with lifetime DMT use and those who have never used DMT. Whether this marks a departure from previous trends is unknown. This study is unable to comment on the context in which DMT was used, a significant factor when considering subjective experiences (Harding and Zinberg, 1984). Mainstream interest since the release of the cult film *Enter the Void* in 2009 and the 2010 documentary *DMT: The Spirit Molecule*, followed by a recent article in the influential youth magazine *Vice* featuring young people who had just smoked DMT (Barclay, 2012), will have raised public awareness. It seems unlikely that these new younger users are experiencing DMT within a spiritual ceremony or an established church environment.

Our findings need to be considered in light of some limitations. This is the largest study of DMT use ever conducted; however, given that the sample was self-nominating, the study participants may not be representative of DMT users in wider population. Although the vast majority of new DMT users were experienced users of psychedelic drugs (with 72% having tried at least one other commonly used psychedelic), the fact that our drug comparisons were not among the same group of users potentially limits the robustness of the comparison data. The findings are also limited by the nature and scope of self-reported experiences enquired about in the current study and, as in all such studies, there is no way of confirming the true composition of substance consumed. These limitations and others have been discussed at length elsewhere (McCambridge et al., 2006, Winstock et al., 2001, 2011a, 2012). Despite these potential limitations, we have previously shown that self-report studies among sentinel drug-using groups may be a valid and effective tool for describing the effect profile of novel drugs and detecting the appearance of new drugs (Winstock et al., 2002, 2011a). We accept that, when compared with traditional epidemiological criteria for a good public health surveillance system, this method has significant limitations. High levels of poly-drug use, confounding effects from other substances and recall bias are all significant issues. No information was obtained on important issues such as dose, the setting or context of use and whether individuals were experienced safety conscious users. It is an artefact of the global nature of our sample that there will be unavoidable differences in local drug markets, availability and preparation, but this was not the focus of our study. We believe, however, that our approaches can usefully guide future research as well as inform those who choose to use novel substances.

Conclusions

When compared with the common psychedelic drugs of use, the modern subjective report of DMT use from a sample of 472 new users was described as a short, intense and pleasurable experience with negligible negative effects. In this population, recruited via an online drug survey advertised in mainstream and dance music-related media, the lifetime prevalence of DMT use was 9%, making it an uncommon but important substance of global significance. Supporting findings from previous studies, DMT was typically smoked and, although it seems to have positive attributes, its potential for abuse appears to be low. Like other psychedelic substances, DMT's profound effects on consciousness may limit its appeal to the wider population and likely prevent habitual use, except in those who use it in within a religious context.

Conflict of interest

Adam R Winstock is the founder and director of the Global Drug Survey Ltd.

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